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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Specification for Welded Copper-Alloy Pipe[1]

This standard is issued under the fixed designation B 608; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope *

1.1 This specification establishes the requirements for arc-welded pipe for use in brackish water or seawater piping systems.

1.2 Values stated in inch-pound units are the standard. SI values given in parentheses and in the tables are for information only.

1.3 The following hazard statement pertains only to the test method described in 8.2 and 14.3.2 of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

B 169 Specification for Aluminum Bronze Plate, Sheet, Strip, and Rolled Bar[2]

B 171 Specification for Copper-Alloy Plate and Sheet for Pressure Vessels, Condensers, and Heat Exchangers[2]

E 8 Test Methods for Tension Testing of Metallic Materials[3]

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[4]

E 62 Test Methods for Chemical Analysis of Copper and Copper Alloys (Photometric Methods)[5]

E 76 Test Methods for Chemical Analysis of Nickel-Copper Alloys[5]

E 190 Test Method for Guided Bend Test for Ductility of Welds[3]

E 255 Practice for Sampling Copper and Copper Alloys for the Determination of Chemical Composition[5]

E 478 Test Methods for Chemical Analysis of Copper Alloys[5]

2.2 *AWS Standards:*[6]

A 5.7 Copper and Copper-Alloy Arc-Welding Electrodes

A 5.7 Copper and Copper-Alloy Welding Rods

2.3 *ASME Standards:*[7]

Boiler and Pressure Vessel Code, Nuclear Power Plant Components, Section III, Division I

Boiler and Pressure Vessel Code, Nondestructive Examination, Section V

Boiler and Pressure Vessel Code, Pressure Vessels, Section VIII, Division I

Boiler and Pressure Vessel Code, Welding Qualifications, Section IX

3. Terminology

3.1 *Definitions:*

3.1.1 *arc-welding*, *n*—a group of welding processes wherein coalescence is produced by heating with an electric arc or arcs, with or without the application of pressure and with or without the use of filler metal.

3.1.2 *as-welded condition*, *n*—the result of forming annealed sheet or plate into tubular form and welding without subsequent heat treatment or cold work.

3.1.3 *base metal*, *n*—the sheet or plate from which the pipe is formed.

3.1.4 *weld reinforcement*, *n*—the portion of the welded joint which extends beyond the inner and outer surface of the base metal of the welded pipe.

3.2 *Terms Specific to This Specification:*

3.2.1 *capable of*, *adj*—possessing the required properties or characteristics, or both, necessary to conform to specification requirements when subjected to specified test(s).

3.2.2 *rehearing*, *n*—a petition by the manufacturer or supplier to the purchaser, as a result of material rejection, for additional testing to be conducted by the manufacturer or supplier and the purchaser. Identical samples of the product are to be tested by both parties using a method(s) specified in the product specification. Alternatively, upon agreement of both parties, an independent laboratory may be selected for the tests using the specified methods.

4. Ordering Information

4.1 Contracts or purchase orders for product furnished under this specification should include the following information:

[1] This specification is under the jurisdiction of ASTM Committee B-5 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.04 on Pipe and Tube.

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[2] *Annual Book of ASTM Standards*, Vol 02.01.

[3] *Annual Book of ASTM Standards*, Vol 03.01.

[4] *Annual Book of ASTM Standards*, Vol 14.02.

[5] *Annual Book of ASTM Standards*, Vol 03.05.

[6] Available from the American Welding Society, 2501 North West 7th Street, Miami, FL 33125.

[7] Available from the American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017.

***A Summary of Changes section appears at the end of this standard.**

4.1.1 ASTM specification designation and year of issue, (for example, B 608 – XX),

4.1.2 Copper alloy UNS No. required (Section 5 and Table 1),

4.1.3 Dimensions required; diameter and wall thickness (Section 10),

4.1.4 Unit length required, and

4.1.5 When purchased for *ASME Boiler and Pressure Vessel Code* application.

4.2 The following options are available:

4.2.1 Determination of chemical composition (Section 6.1.1),

4.2.2 Guided bend test (Section 8.1),

4.2.3 Hydrostatic test (Section 8.2),

4.2.4 Radiographic examination (Section 8.3),

4.2.4.1 The number of pipe lengths to be examined,

4.2.5 Liquid penetration examination (Section 8.4),

4.2.6 Weld reinforcement removal, (Section 8.5),

4.2.7 Certification (Section 18), and

4.2.8 Test Report (Section 19).

5. Material and Manufacture

5.1 *Material*:

5.1.1 The pipe shall be made from annealed copper alloy sheet or plate that conforms to the requirements of Specification B 169 for Copper Alloys UNS Nos. C61300 and C61400 or Specification B 171 for Copper Alloys UNS Nos. C70600 and C71500.

5.2 *Manufacture*:

5.2.1 Welded joints shall be made either manually or automatically by an arc welding process.

5.2.2 Filler metal, if used in an arc-welding process, shall conform to one of the following specifications and classifications shown for each base metal:

Base Metal Copper Alloy	Filler Metal AWS Specification	
UNS Number	A5.6	A5.7
C61300	ECuAl-A2	ERCuAl-A2
C61400	ECuAl–A2	ERCuAl–A2
C70600	ECuNi	ERCuNi
C71500	ECuNi	ERCuNi

5.2.3 Welding procedures and welding operators shall be qualified in accordance with the *ASME Boiler and Pressure Vessel Code*, Section IX.

5.2.4 Each length of pipe may contain more than one longitudinal welded joint.

5.2.4.1 The welded joint shall be a full-penetration weld and may have a reinforcing bead on each side; such reinforcement shall not be more than 1/16 in. (1.6 mm) per side measured in the radial direction.

5.2.4.2 At no place shall the thickness of the weld section be less than the thickness of the adjacent base metal.

5.2.4.3 The contour of the weld bead shall be smooth, having no sharp valley or groove at the weld center or edges.

5.2.4.4 Smooth concavity of the weld bead contour is acceptable provided the minimum weld bead thickness is not less than the thickness of the adjacent base metal.

5.2.4.5 Any offset of base metal edges at a weld that is within the tolerance of 9.2.7 shall be faired at a 3 to 1 minimum taper over the width of the finished weld, or if necessary, by adding additional weld metal beyond what would otherwise be the edge of the weld. Such build-up welding shall be performed in accordance with the requirements of 5.2.3.

5.2.4.6 Weld reinforcement may be removed at the option of the manufacturer or when specified by the purchaser.

5.2.5 Weld defects shall be repaired by removal to sound metal and rewelding. A repaired weld shall meet all requirements of an original weld.

5.2.6 Base metal defects such as slivers, inclusions or laps shall be repaired by removal to sound metal. Build-up welding shall be performed when such removal reduces the wall thickness below the minimum allowed by the specification. Such build-up welding shall be performed in accordance with the requirements of 5.2.3. The thickness of the repaired section shall meet the requirements of a welded joint.

5.2.7 Pipe shall be furnished in the as-welded condition (Section 3).

NOTE 1—Although no restriction is placed on the size of pipe that may be furnished under this specification, usuage is normally limited to normal sizes 4 in. (101 mm) and larger in diameter.

6. Chemical Composition

6.1 The pipe material shall conform to the requirements of Table 1 for the specified alloy.

6.1.1 When the material of manufacturer has been certified to conform to the requirements of the strip specification to which it was ordered, the determination of composition is not required of the tube manufacturer or supplier unless specified in the contract or purchase order.

6.2 These specified limits do not preclude the presence of other elements. Limits may be established and analysis required for unnamed elements by agreement between the manufacturer or supplier and the purchaser.

6.3 When determining composition, copper may be taken as

TABLE 1 Chemical Requirements

	Composition, %										
Copper Alloy UNS Number	Copper[A]	Nickel incl Cobalt	Aluminum	Lead, max	Iron	Zinc, max	Manganese, max	Sulfur, max	Phosphorus, max	Carbon, max	Tin
C61300[B]	remainder	0.15 max	6.0–7.5	0.01	2.0–3.0	0.10	0.20	...	0.015	...	0.20–0.50
C61400	remainder	...	6.0–8.0	0.01	1.5–3.5	0.20	1.0	...	0.015	...	...
C70600	remainder	9.0–11.0	...	0.02	1.0–1.8	0.50	1.0	0.02	0.02	0.05	...
C71500	remainder	29.0–33.0	...	0.02	0.4–1.0	0.50	1.0	0.02	0.02	0.05	...

[A] Silver counting as copper.

[B] When the product is for subsequent welding applications and is so specified by the purchaser, chromium shall be 0.05 % max, cadmium 0.05 % max, zinc 0.05 % max, and zirconium 0.05 % max.

the difference between the sum of results for specified elements and 100 %.

6.4 When all elements in Table 1 for the specified alloy are determined the sum of results shall be as follows:

Copper Alloy UNS No.	Copper Plus Specified Elements, Percent, %, Minimum
C61300	99.8
C61400, C70600, C71500	99.5

7. Mechanical Property Requirements

7.1 *Transverse Tensional Strength*:

7.1.1 With the test taken across any weld, the pipe shall be capable of conforming to the value given in Table 2 for the particular alloy.

8. Performance Requirements

8.1 *Transverse Guided-Bend Test*:

8.1.1 The transverse face and root guided bend test shall be taken with the weld in the center of the test specimen and there shall be no open defects exceeding 0.125 in. (3.18 mm) measured in any direction on the convex surface of the specimen when tested in accordance with Test Methods E 190. Cracks originating from corners of the specimen shall not be considered.

8.1.2 This test is not required unless specified in the contract or purchase order.

8.2 *Hydrostatic Test*:

8.2.1 Each length of pipe shall be capable of withstanding an internal hydrostatic pressure sufficient to produce a fiber stress of 7 000 psi (48 MPa) without showing evidence of weakness, defects, or leakage.

8.2.1.1 This requirement is not recommended for pipe with an outside diameter greater than 24 in. (610 mm).

8.2.2 No pipe size need be subjected to a pressure gage reading greater than 1 000 psi (6 900 kPa).

8.2.3 This test is not required unless specified in the contract or purchase order.

8.3 *Radiographic Examination*:

8.3.1 When specified in the contract or purchase order, pipe shall be examined in accordance with the procedure and acceptance criteria of the *ASME Boiler and Pressure Vessel Code*, Section III, Division 1, or Section VIII, Division 1, as specified.

8.3.1.1 The number of pipe lengths to be examined shall be specified by the purchaser.

8.3.2 All welded joints in any individual length of pipe shall be radiographed completely.

8.4 *Liquid Penetration Examination*:

8.4.1 When specified in the contract or purchase order, all welded joints in all lengths of pipe shall be examined, both the inside and outside surfaces, in accordance with the procedure and acceptance criteria of the *ASME Boiler and Pressure Vessel Code*, Section III, Division 1, or Section VIII, Division 1, as specified.

TABLE 2 Transverse Tensile Strength

Copper Alloy UNS Number	Tensile Strength, min, ksi (MPa)[A]
C61300	70 (485)
C61400	70 (485)
C70600	40 (275)
C71500	50 (345)

[A] See Appendix X1.

9. Weld Reinforcement Removal

9.1 When specified in the contract or purchase order, weld reinforcement shall be completely removed from the inside surface and outside surface longitudinal welded joints.

9.2 Weld thickness shall conform to wall thickness requirements after removal of reinforcement.

10. Dimensions and Permissible Variations

10.1 *Dimensions*:

10.1.1 Pipe diameter shall be specified as a nominal diameter in inches as shown in Table 3, Table 4, or Table 5.

10.1.2 Pipe wall thickness shall be that shown in Table 3, Table 4, or Table 5 for the diameter and pressure class specified.

10.1.3 If a pipe outside diameter or wall thickness, not specified in Table 3, Table 4, or Table 5 is desired, the diameter and the wall thickness shall be specified in decimal fractions of an inch.

TABLE 3 Standard Sizes and Wall Thickness
Copper Alloy UNS Nos. C61300 and C61400

Inch-Pound Units, Thickness, in.						
Diameter, in.		Pressure Class, psi[A]				
Nominal	Outside	50	75	100	150	200
4	4.50	0.094	0.094	0.094	0.094	0.094
5	5.563	0.094	0.094	0.094	0.094	0.094
6	6.625	0.094	0.094	0.094	0.094	0.094
8	8.625	0.094	0.094	0.094	0.094	0.094
10	10.75	0.094	0.094	0.094	0.125	0.125
12	12.75	0.094	0.094	0.094	0.125	0.165
14	14.00	0.125	0.125	0.125	0.125	0.165
16	16.00	0.125	0.125	0.125	0.134	0.187
18	18.00	0.125	0.125	0.125	0.165	0.187
20	20.00	0.125	0.125	0.125	0.165	0.250
24	24.00	0.125	0.125	0.134	0.187	0.250
30	30.00	0.134	0.134	0.165	0.250	0.312
36	36.00	0.134	0.165	0.187	0.312	0.375
42	42.00	0.187	0.187	0.250	0.312	0.437
48	48.00	0.187	0.187	0.259	0.375	0.437
SI Units, Thickness, mm						
Diameter, in.		Pressure Class, kPa[A]				
Nominal	Outside	345	517	689	1034	1379
4	4.50	2.38	2.38	2.38	2.38	2.38
5	5.563	2.38	2.38	2.38	2.38	2.38
6	6.625	2.38	2.38	2.38	2.38	2.38
8	8.625	2.38	2.38	2.38	2.38	2.38
10	10.75	2.38	2.38	2.38	3.18	3.18
12	12.75	2.38	2.38	2.38	3.18	4.19
14	14.00	3.18	3.18	3.18	3.18	4.19
16	16.00	3.18	3.18	3.18	3.40	4.76
18	18.00	3.18	3.18	3.18	4.19	4.76
20	20.00	3.18	3.18	3.18	4.76	6.35
24	24.00	3.18	3.18	3.40	4.76	6.35
30	30.00	3.40	3.40	4.19	6.35	7.94
36	36.00	3.40	4.19	4.76	7.94	9.53
42	42.00	4.76	4.76	6.35	7.94	11.1
48	48.00	4.76	4.76	6.35	9.53	11.1

[A] Pressure ratings apply to any design temperature not exceeding 350°F (176°C). Pressure ratings are calculated for each size and pressure class based on a corrosion allowance of 0.020 in. (0.508 mm), a weld efficiency of 70 %, and the thickness tolerances shown in Table 8Table 8.